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ABSTRACT

Practitioner use of learning style theory and measures can have an impact on curriculum design, instruction and assessment methods, and student guidance in the secondary school. Concern about the "operationalization" of learning style continues due to confusion concerning definitions, weakness in reliability and validity of measurements, and problems with the accurate identification of the most relevant characteristics of learners and instructional settings. A new taxonomy of learning styles, designed to help practitioners interpret information derived from learning style measures, is offered. The taxonomy integrates several strong conceptualizations of learning style. The central idea behind the taxonomy is that learner success in any "teaching-learning situation" requires positive motivation on the part of the student. Such motivation will lead to a sufficient degree of engagement in the task and to active task processing that will integrate the new information into long-term memory. A total of 13 learning style theories are summarized and discussed in terms of their contributions to the taxonomy. The document also summarizes selected literature concerning positive results for students whose learning style is matched to features of instruction, testing, and direct training. Areas for further research are suggested and the use of learning style theory and measures by practitioners is encouraged. (RH)

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LEARNING STYLES IN SECONDARY SCHOOLS: A REVIEW OF INSTRUMENTS AND IMPLICATIONS FOR THEIR USE

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EXECUTIVE SUMMARY

LEARNING STYLES IN SECONDARY SCHOOLS: A REVIEW OF INSTRUMENTS AND IMPLICATIONS FOR THEIR USE

The purpose of this review is to encourage the thoughtful use of learning style concepts in secondary school classrooms. There are four areas of potential impact: curriculum design, instructional methods, assessment methods, and student guidance. Theoretically, learning styles offer the opportunity to modify the structure and order of curriculum units to better suit individual students. Instructional methods can also be tailored more specifically to student needs according to learning style theory and measurements, and a case is made that individual differences in student learning style will affect performance in assessment situations. Learning style theory can also fortify student guidance services by soliciting student engagement in diagnosis, discussion and adaptive planning to make the best use of the student's particular constellation of learning styles.

There are three general areas for continuing concern about the operationalization of learning style: (1) confusion in definitions; (2) weakness in reliability and validity of the measurements; (3) identification of relevant characteristics in learners and instructional settings. The variation in definitional scope and nomenclature across the learning styles field makes it difficult to see relationships among the various concepts. The tendency in learning styles theory in measurement is to rush into print and marketing efforts with only early evidence to support interpretations from the test scores. Writers and researchers in learning style theory and measurement have not pursued research programs to establish construct validity based on distinguishing among related concepts. There is still considerable debate about which possible applications of learning styles within educational settings are effective.

A new taxonomy of learning styles is offered which integrates several of the strongest existing learning style conceptualizations. The central idea behind the taxonomy is that learner success in any teaching-learning situation requires positive motivation on the part of the student which will lead to a sufficient degree of engagement in the task and thereby result in active task processing (cognitive control) to integrate the new information into long term memory. This entire process is influenced by students' preferences for various conditions in the physical environment and preferences for different forms of social interaction. Various learning style theorists have previously identified such aspects of motivation, task engagement and cognitive control, but they have not been organized into an integrated scheme. Thirteen of the strongest available learning style theories are displayed according to their contributions in the proposed taxonomy, and each of the thirteen suggested learning style instruments is summarized.

A selection of literature is summarized which indicates positive results for students from matching student learning style to features of instruction and testing. Literature is also summarized on the efficacy of direct training on aspects of motivation, engagement and cognitive controls.

Areas for further research are suggested, and practitioners are encouraged to consider incorporating aspects of learning style theory and measurement in their efforts to respond to individual differences among students.

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I. INTRODUCTION

The objective for this review is to encourage the thoughtful use of learning style concepts in secondary school classrooms. There is some evidence that careful use of learning style information improves attitudes towards learning and school achievement. Given the present pressure on secondary schools to accomplish more with constrained resources, learning styles may contribute to educational efficiency.

A. General Rationale for Interest in Learning Styles

The primary objective for the study and application of learning styles has been to improve the immediate and long-term results of instruction (for example Andrews, 1981; Biggs, 1979; Biggs, 1988 (c); Lynch, 1981; Papalia, 1978; Pizzo, 1981; Shea, 1983; Smith & Renzulli, 1983; Weinberg, 1983). Use of learning styles can have impact on teaching and learning in secondary schools in four areas: (1) curriculum design; (2) instructional methods; (3) assessment methods; (4) student guidance.

Curriculum Design

Curriculum usually defines common learning goals in a specific content area. For example, a high school science curriculum will describe a series of skill and knowledge units that all students are expected to master in a given period of time. A curriculum can be judged according to the degree of adaptability it allows for individual students and teachers. Some curricula are designed in pre-packaged units with a narrow range of teaching and learning materials not to be supplemented by the teacher. Such curricula provide little opportunity for teachers and learners to capitalize on their unique aptitudes or to avoid experiences that may be counterproductive.

Other curricula have been specifically designed to take into account individual differences among learners. The Individually Guided Education (I.G.E) (Popkewitz, Tabachnick, & Wehlage, 1982) and the Adaptive Learning Environment Model (A.L.E.M.) (Wang, 1980) were both designed to vary the educational interaction among teachers, learners and materials by following individually assessed profiles of student aptitudes and preferences. Unfortunately, these curricula are usually focused only on individual differences in content-related ability and preferred pace of instruction. Learning styles theoretically also offer the opportunity to modify the structure and order of curriculum units to better suit individual students.

Instructional Methods

Instructional methods include all teacher actions, materials and events which are pre-planned to occur in the teaching-learning situation. Teachers are often dissatisfied with providing one standard experience for entire groups of students, and they make some effort to tailor their interaction with each student to that student's needs. These adaptations can be better informed using learning style theory and measurements. As pointed out by Corno and Snow (1986), at present the bulk of adaptations made by teachers tend to be only quantitative adjustments in time: variation in the amount of time spent with individual students, the amount of time students spend with a particular problem or content area, the

amount of time spent by the class as a whole in a content area. But these rarely involve qualitative change in the nature of interaction.

Assessment Methods

It follows that if individual differences in learning style have an effect on how individuals approach learning situations, information demands and problem solving in instructional settings, then these same individual differences will have an effect on student performance in assessment situations. Teachers have long known that some students display their mastery levels more accurately on different kinds of examinations, for example essays versus multiple choice tests. Learning style theorists argue that students' examination scores will reach optimal levels when the measurement format matches the student's learning style, which may also be the instructional format with which the student is the most productive.

Student Guidance

Snow (1986) contrasts three different paths for systematic design of adaptive education: individual paths for pursuit of individual goals, alternative paths towards common goals, and paths designed to remediate weaknesses (inaptitudes) directly. The case of alternative paths towards common goals has been addressed earlier under sections on curriculum design and instructional methods. The issue of individual paths to individual goals touches on the functions of guidance counseling. In the past, guidance counseling has concentrated primarily on career information. Learning style theory offers the additional opportunity for guidance to focus on diagnosis and adaptative planning to make best use of the student's particular constellation of learning styles.

B. Issues in Learning Style Use

There are three general areas for continuing concern about the operationalization of learning style theory: (1) confusion in definitions; (2) weakness in reliability and validity of measurements; (3) identification of the most relevant characteristics in learners and instructional settings.

Confusion in Definitions

The first issue is the bewildering confusion of definitions surrounding learning style conceptualizations. There is wide variation in the scale and the scope of learning, school achievement and other behavior predicted by the various learning style concepts. Some claim to predict only an individual's expressed preference between a lecture-style instructional method versus small-group instructional method (Friedman & Stritter, 1976); others attempt to predict habitual behaviors across all learning acts (Yando & Kagan, 1970). Definitions also reflect loose distinctions between style, strategy and tactics. There may be some consensus emerging in the literature towards using the word "style" to refer to information processing routines which function in a trait-like manner at the personality level (Entwistle, 1981); "strategies" to refer to cross-situational consistency in how students approach school learning (Entwistle, 1988, Ramsden, 1988); and "tactic" to describe the

specific, observable activity of learners in a specific learning situation (Snowman, 1989).

This variation in scope and nomenclature across the instruments makes it difficult to see relationships among the various concepts of cognitive and learning styles. Some efforts have been made to classify the many cognitive-learning style instruments. In 1983 I proposed a three-level model (1983) that divided cognitive and learning style measures into groups based on the authors' intent to measure instructional preference, information processing tendencies and personality descriptors. The hypothesis accompanying the model was that the degree of temporal reliability in each dimension would vary depending on the main intent of the instrument. For example, measures of individuals' instructional preference would be less stable over time than would measures of personality dimensions. Analysis of reliability for the reviewed instruments supported the hypothesis. Ingham (1989) recently validated the concept of onion-like levels in prediction patterns between learning style and instructional format. The Curry model (1983) of organizing learning style conceptualizations has been built upon by Claxton & Murrell (1987) who added a fourth dimension: social interaction preference. Melear (1989) used the Curry model to explain the relationship observed between the new learning style instrument from the National Association of Secondary School Principals (Keefe & Monk, 1989) and the Myers Briggs Trait Indicator (Myers, 1962).

Since my synthesis of 1983, much research and developmental work in learning style diagnosis has been accomplished. The new learning style taxonomy proposed in this monograph integrates across the best information to date.

Reliability and Validity of Measures

Developers of learning style conceptualizations have collected varying degrees and types of evidence to support their conceptualization and measurement systems. Test users should expect evidence indicating that the instrument meets minimum standards for use and interpretation. A statement of the minimum standards for educational and psychological testing was jointly issued by the American Psychological Association, the American Educational Research Association and the National Council for Measurement in Education in 1985. This is the fourth edition of these standards, the first being issued in 1954. The major sections of the Standards are: (1) validity, (2) reliability and errors of measurement, (3) test development and revision, (4) scaling, norming, score comparability and equating, and (5) test publication.

The standards emphasize that validity is "the most important consideration in test evaluation. The concept refers to the appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores. Test validation is the process of accumulating evidence to support such inferences" (American Psychological Association, 1985, p. 9).

Tests of learning style purport to describe an individual by reference to a range of theoretical concepts constituting some version of learning style theory. These learning style theories describe to varying degrees what individuals with more or less of a certain attribute would do under various learning conditions. Test developers make the claim that getting a certain test score on their learning style measure can be interpreted as evidence of the

degree to which the student possesses a characteristic critical in their learning style theory. The process of validating these interpretations requires construct-related evidence. "In order to show that a given construct applies to a test, it is necessary to derive hypotheses about test behavior from theory related to the construct and verify them experimentally" (Cronbach, 1970, p. 123). Regrettably, however, the tendency in the learning styles theory and measurement literature is not to pursue a continuing pattern of hypothesis formation, testing, and modification but rather to rush prematurely into print and marketing with only early and preliminary indications of factor loadings based on one data set. This haste weakens claims of validity in interpretation of test scores.

Cronbach (1970) reminds us that to determine whether a test measures a certain variable defined by a theory, we should look basically for two things. "The first is convergence of indicators. There needs to be two or more different kinds of data that are regarded as suitable evidence that a person is high or low on the variable. If these indicators agree, despite their surface dissimilarity, we place greater faith in the proposed theoretical interpretation...The second kind of evidence is divergence of indicators that are supposed to represent different constructs" (p. 144). Writers and researchers in learning style theory and measurement have not often pursued this process of carefully distinguishing among like concepts as a method to collect construct-related evidence. Thus the test user has little or no indication of the degree of overlap across the various learning style conceptualizations, nor much convincing evidence that the interpretations are valid for the test results observed.

The second most important standard for interpreting educational and psychological tests is reliability of measurement. Any test score is subject to many influences and sources of error that mask the "true" value of the variable being measured. The test user wants an indicator that minimizes the variance from the "true" value. Test developers have an obligation to provide users with estimates of the expected sources of variance in their measurement system. Reporting this information will allow a test user to decide whether the finished test is accurate enough for the interpretation required. Generally speaking, the developers of learning style instruments have provided information about reliability, but usually have not with the more recent methods of identifying and estimating variance components. It is rare, for example, to find standard errors of measurement reported for test scores near the cut scores for the various learning style classification decisions.

Relevant Characteristics for Intervention

The third continuing issue is to identify accurately which of many possible adaptations within educational settings will be effective when used with information on learning styles. Progress here requires creative development of alternative approaches in curriculum and instruction, careful matching of selected learning style concepts to these variations and evaluation designs sensitive enough to distinguish real effects. Some learning style theorists have conducted repeated small studies which tend to find supporting evidence for their own conceptualizations. In general, however, these studies have not been designed to facilitate the emergence of disconfirming evidence; they are vulnerable to "halo" and participation effects, and they involve relatively small, selective samples.

A related issue is whether optimal results are achieved when students are systematically matched to curriculum instructional methods according to their learning style or whether, for some purposes, they ought to be carefully mismatched. Witkin, Moore, Goodenough, & Cox (1977) suggested that matching students with teachers or instructional materials according to their cognitive styles might facilitate the students' initial acquisition of skills and provide important continued motivation. An alternative point of view has been articulated by Shipman and Shipman (1985): "it is our belief that in a complex changing society with diverse environmental demands, students need the opportunity to become sensitive to and proficient in multiple alternative strategies" (p. 283). Snow and Lohman (1984) suggest matching student style to instructional format for the initial stages of learning and then moving to systematic mis-matches as the student becomes more proficient with the material.

Kirby (1988) and Pask (1988) argue that the best learning "style" for benefitting from instruction is to avoid depending upon any single style, or any style-like consistency in approach. They both advocate that learners take a very flexible approach to instruction, one that can be easily modified as more cues become available about the learning conditions. Kirby refers to this flexibility as a "synthetic style"; Pask calls it a "versatile style."

In all these considerations the object is the same: to optimize what the learner gets out of each formal instructional situation that is useful in the long term, not just useful for copping with the instructional situation in the short term. Developing the flexibility to respond productively to all sorts of instructional situations would be a laudable goal for each student. The question remains: how to best encourage this flexibility?

To learn more about how to apply information on students' learning styles will require not only good measures of learning style, but also a comprehensive measurement system that provides valid information about which individual characteristics of learners interact with which factors in the teaching-learning situation and how this affects student progress: Expert teachers may be able to perceive sufficient information about individual differences in learning style without using formal diagnostic instruments. They may be able to use their own clinical judgment about how the student is coping and learning, and appropriately modify the instructional factors so that style flexibility is gained even without the students' conscious participation in trying to develop a flexible learning style. I believe, however, that in secondary schools, formal staff training and deliberate instruction to build style flexibility in students is likely to be more productive than less systematic efforts.

II. AN INTEGRATED TAXONOMY OF LEARNING STYLES

The taxonomy proposed below provides a simple, encompassing framework that integrates some of the strongest existing learning style conceptualizations. The taxonomy is intended to assist practitioners in interpretating the information gained from each learning style measure. Developers of these learning style conceptualizations, or their many derivatives, may quarrel with the taxonomy or with how their concepts have been placed

and explained. The taxonomy is offered, nevertheless, in a collegial spirit to summarize aspects of convergence and divergence across learning style and related concepts.

The central idea here is that learner success in any teaching-learning situation requires positive motivation on the part of the student which then leads to a sufficient degree of engagement in the task, and results in active effort, behavior and cognitive processing to integrate the new information into long-term memory. These ideas are consistent with the model of school learning outlined by Carroll (1963) which included student perseverance as a pivotal variable, and also with empirical studies showing that student effort and involvement directly affects student achievement regardless of student ability (Grabe, 1982). The influence of learning styles or success in academic tasks may be related to maintenance of motivation, level of engagement and specific information processing habits.

McCombs (1988) reviewed the literature on the role of motivation in strategic behavior, concluding that a will to maintain motivation in a particular kind of situation is dependent upon the maintenance of a general sense of self-efficacy and a sense of self-control in that situation. The sense of self-control may be connected or influenced by a sense of control over that particular situation. This observation is consistent with many of the learning style instruments that measure learner preferences for various physical and social dimensions in learning situations. These preferences for particular physical environmental conditions and for particular social conditions are factors that can be altered in the learning situation and may have direct bearing on motivation.

A student's prior history with learning situations similar to the new one encountered will have an effect on that student's engagement in the intended learning behavior. In the taxonomy presented here this "engagement level" is the point of contact between the motivational condition of the learner entering the new learning situation and the active processing work required by the new learning task. The engagement level of the student will be reflected in how much attention the student will pay to features in the instructional situation, how persistent the student will be, his/her degree of participation, as well as the enthusiasm, and degree of concentration the student will sustain through and beyond the instructional situation.

Newmann (in press) defines "student engagement" as "the student's psychological investment in learning, understanding or mastering the knowledge, skills or crafts that academic work is intended to promote." Newmann suggests that the degree of student engagement in academic work results largely from three factors: "students' underlying need for competence, the extent to which they experience legitimate membership in the institution, and the quality of the specific academic tasks they are asked to complete." Various concepts used to describe learning styles also help to describe student engagement levels. See for example Biggs (1988c), and Entwistle (1988).

Students bring a series of cognitive information processing habits, or preferences to new learning situations. A number of these have been identified by psychologists studying individual differences: field dependence versus independence (Witkin et al., 1954), levelling versus sharpening (Gardiner et al., 1959), breadth of categorizing (Pettigrew, 1958),

conceptual versus perceptual (Broverman, 1960), perceptual modality differences (Messick et al., 1976), scanning versus focusing (Holzman, 1954), cognitive complexity versus simplicity (Bieri et al., 1966), reflectivity versus impulsivity (Kagan et al., 1964) and tolerance versus intolerance (Klein, Gardner, & Schlesinger, 1962). Letteri (1976) characterized performance on seven of these types of information processing habits as "cognitive controls". His research indicates high correlations between academic achievement and the following style components: analytic, focused, reflective, narrow categorization, complexity, sharpening and tolerance. Letteri (1980) used these seven bi-polar measures and grouped students into three types: those who test at the high end of all seven cognitive control variables, those in the middle and those at the low range. He reported that Type 1 individuals were in the top 20% of achievement in standardized and teacher-made tests, Type 2 individuals were in the middle range of achievement and Type 3 individuals were in the bottom 20%.

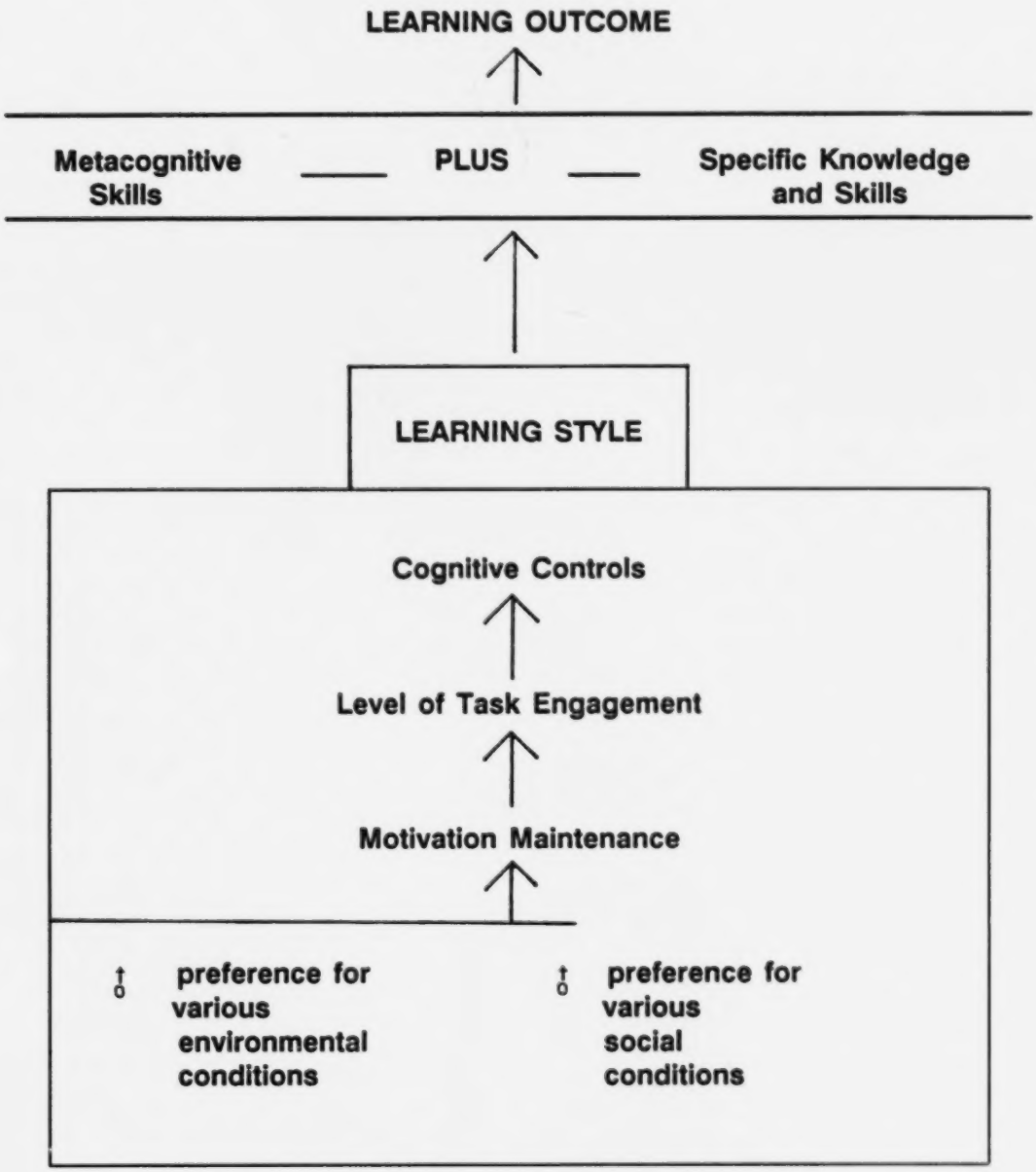
The learning style taxonomy presented here is consistent with the thinking of Newmann, McCombs, and Letteri, and with the evidence provided by particular learning style theorists. In addition, it offers a way of linking motivation, engagement and cognitive control. The suggested connection is that engagement implies intention and willingness to stay focused on a particular task in a particular situation. Motivation must be maintained in order to so do. The level of engagement allows information to be processed with whatever habitual degree of cognitive control the student has mastered. Learning style itself can be conceived as a combination of one's motivation, engagement, and cognitive processing habits.

As summarized in Figure 1, the new taxonomy of learning styles concepts also recognizes the fundamental influence of preferences for environmental conditions and preferences for social conditions which combine to affect the maintenance of motivation. The motivational state in turn affects the engagement level of the learner in the new task. Once the student becomes engaged in the task, some habitual or preferred cognitive information processing relevant to the task will take place, at least initially. These components are organized hierarchically because it seems that preferences for environmental and social conditions would have a more direct effect on motivation maintenance than they would levels of task engagement or cognitive control. Task engagement, in turn, would be more directly affected by motivation. Task-relevant cognitive information processing or cognitive control would not be likely unless adequate task engagement was maintained. Maintenance of motivation, level of engagement and cognitive processing then combine to make use of previously learned metacognitive skills such as situation analysis planning, self-pacing, self-evaluation and with the specific knowledge and skills learned in the instructional situation to produce a detectable learning outcome.

The various learning style theorists have identified aspects of motivation, task engagement and cognitive control as part of their own learning style conceptualizations. Figure 2 displays the contributions of thirteen learning style theorists according to the proposed taxonomy. The instruments are summarized briefly in section III and more detailed information is offered in the appendix.

Figure 1.

Learning Style Taxonomy and Contributions of
Learning Style to Learning Outcomes



	Environmental Conditions Preference	Social Conditions Preference	Typical Engagement Level	Cognitive Information Processing Preference
1. Biggs	describes 4 summative types of motive states			
2. Dunn	noise, light, temperature, design, food, time, mobility	peers, authority	persistence	perceptual response
	general motivational level			
3. Entwistle	describes 4 summative types of motive states			
4. Hunt		interpersonal maturity		conceptual complexity
5. NASSP (Keefe, Monk)	sound, light, temperature, time, mobility, posture, manipulation	grouping	persistence verbal risk	cognitive elements (8) perceptual response
A. Grasha		independent-dependent avoidant-participant collaborative competitive		
B. Kagan				impulsivity-reflectivity
C. Kolb				concrete experience vs. reflective observation; abstract conceptualization vs. active experience
D. Myers-Briggs			extraversion-introversion sensing-intuition thinking-feeling judgment-perception	
E. Rezler		individual vs. interpersonal; student vs. teacher structure		abstract-concrete
F. Schmeck	general motive describes: study methods and fact retention			synthesis analysis elaborative processing
G. Weinstein	anxiety, attitudes motivation		concentration	information processing scheduling, main idea, self testing, study aids, test strategies
H. Wilkin				field dependence vs. independence

Figure 2: Relationship of Selected Cognitive Learning Style Measurements Systems to Suggested Model

Note:
Numbers 1 to 5 were developed for use with secondary school populations. Letters A to H could be applied with secondary school populations.

III. INSTRUMENTS

The eight learning style instruments and conceptualizations discussed below were chosen from among over 100 existing learning style instruments. These instruments all have some published evidence of validity and reliability. See the Appendix for a sampling of these indicators. Since only a brief overview of each instrument is presented here, potential users are encouraged to investigate instruments of interest in more depth.

A. Instruments Developed for Use with Secondary School Students

The Biggs Study Process Questionnaire (Biggs, 1988c) consists of 42 self-report items each with Likert five point scales inquiring about three motive-strategy dimensions: surface (instrumental vs. reproducing), deep (intrinsic vs. meaning), and achieving (achievement vs. organizing). The author believes these three dimensions offer a "parsimonious and theoretically coherent model for conceptualizing the more important ways in which students may feel about, and behave towards, their study" (Biggs, 1979). Biggs is interested in both the learner's motive for approaching learning in a particular way and the strategies used to accomplish that motive.

The Dunn, Dunn and Price Learning Style Inventory (Dunn, Dunn, & Price, 1989) uses 100 self-report true/false items to investigate 23 scales grouped into five areas considered likely to affect learning: environmental elements, emotional elements, sociological elements, physical elements and psychological elements. The authors claim that "this instrument analyzes the conditions under which students in grades three through 12 prefer to learn..." (1989, p. 1). Parallel instruments have been developed for use with adults and for grades one and two.

The Approaches to Studying Inventory was developed by Entwistle (1981) to operationalize concepts developed by Marton & Saljo (1976) and Pask (1976) about holistic and serialist learning. The intent was to define approaches to styles of learning in ways which are directly related to the experience of students. The inventory involves 64 Likert items organized into four scales: meaning orientation, reproducing orientation, achieving orientation, holistic orientation. Ramsden (1983) produced the fullest documentation to date on this instrument. He suggests its use in informing teachers about student study patterns so that teachers "will be in a better position to organize their teaching to ensure that students learn effectively" (1983). Entwistle has compared his instrument with the Inventory of Learning Processes developed by Schmeck, Ribich & Ramanaiah (1977). Results of this comparison are outlined below (see section on Schmeck).

The Hunt Paragraph Completion Method (Hunt, Butler, Noy, & Rosser, 1978) involves the open ended completion of six sentences which are then scored by trained raters for level of "conceptual complexity and interpersonal maturity and self-other understanding" (Miller, 1981). The stimulus sentence stems deal with responses to: rules, criticism, parents, being disagreed with, uncertainty and being told what to do.

A very similar conceptualization and methodology was developed by Schroder (Harvey, Hunt, & Schroder, 1961). His Paragraph Completion Test (PCT) asks for an open ended completion of five sentences stems on the following issues: disagreements, doubt, rules, criticism and confusion. Both Hunt and Schroder developed their measures as indicators of "the integrative component of cognitive complexity" which they define as the ability to think in multi-conceptual terms with an orientation towards the structure of thought. The "This I Believe" test developed by O. J. Harvey in conjunction with Hunt and Schroder in 1961 focused on the levels of influenceability of thought, defined by Schroder as the "developmental potential". A detailed review of these three similar approaches to definition and manipulation of "conceptual type" was published by Miller (1981).

In 1986 Keefe and Monk, in conjunction with Letteri, Languis and Dunn first published the *Learning Style Profile for the National Association of Secondary School Principals*. This was updated in 1989 with a total of 126 items each requesting that the student make a choice among three to five alternatives. Scores on these items are allocated to 24 scales grouped into four factors: perceptual response, cognitive style, study preference and instructional preference. The purpose stated for this instrument was to "provide educators with a well validated and easy to use instrument for diagnosing the cognitive styles, perceptual response tendencies and study/instructional preferences of middle level and senior high school students. The profile offers school practitioners a way to personalize the instructional process, to identify the dominant stylistic characteristics of students, and to plan instruction accordingly" (Keefe, 1988, p. i).

B. Other Instruments Potentially Useful with Secondary School Students

The eight instruments reviewed in this section were not designed for secondary school students. However, the concepts they represent and the instruments could, without serious modification, be usefully applied with secondary school populations.

Grasha and Riechman Student Learning Style Scale (Grasha & Riechman, 1974) is a series of 90 Likert-type five point scale items which describe the learner along three bipolar scale dimensions: independent-dependent, avoidant-participant, collaborative-competitive. The scales focus on how students interact with the teacher, other students and the learning task. The goal for these authors was "to develop an instrument that was based on the type of learning styles students demonstrate in the classroom" which they felt was the appropriate approach "if teachers are to innovate and take student learning needs into consideration."

Kagan published the *Matching Familiar Figures Test* in 1964. This test is composed of 12 visual items each involving meaningful line drawings and requiring a match to one of six or eight available targets. Each item is timed and scored for accuracy of the match. The scoring positions each respondent on a bipolar scale purporting to measure conceptual tempo or a tendency to venture answers with cursory versus careful search. The author's label for this style difference is reflectivity versus impulsivity. The concept was developed to reflect the degree that people will reflect on the validity of possible solutions in problems with multiple or ambiguous answers.

The Kolb Learning Style Inventory (LSI) (Kolb, 1976, 1985) consists of nine items, each offering a choice of four sub-items to be rank-ordered by respondents. These responses are organized into two bipolar concepts: concrete experience vs. reflective observation, and abstract conceptualization vs. active experimentation.

At least four variations on this model are in use today. Two have evolved in business applications: McKenney and Keen (1974) presented a Kolb-like model with two bipolar concepts (information evaluation and information gathering) measured in students of business administration by 12 standard reference tests for cognitive factors developed by the Educational Testing Service. Honey and Mumford (1982) credit Kolb with stimulating their work to identify four types of business managers (activist, reflector, theorist and pragmatist) which they describe in terms almost identical to Kolb. Marshall and Merritt (1985) have also developed an alternative measurement format for the Kolb procedure. Gregoric and Ward (1977) developed a Kolb-like bipolar scale (abstract/concrete and sequential/random) based on observations and interviews with teachers and learners.

The Myers-Briggs Type Indicator (MBTI) published in 1962 contains 143 forced choice items each with four alternatives. Each choice is linked with one of four bipolar concepts: extraversion vs. introversion, sensing vs. intuition, thinking vs. feeling and judgement vs. perception. This instrument was developed to measure the constructs in Jung's theory of personality types. The pattern of results generated by the four bipolar concepts are interpreted in terms of Jungian personality theory which in turn is used to predict behavior and attitudes.

The Rezler and Rezmovic Learning Preference Inventory (LPI) (Rezler & Rezmovic, 1981) consists of 15 items in each of which the learner is asked to rank-order six choices. The choices represent three bipolar concepts: abstract vs. concrete, individual vs. interpersonal, student structure vs. teacher structure. The LPI was constructed "to identify preferred modes of learning" with preference defined as the "choice of one learning situation or condition over another."

The Schmeck, Ribich and Ramanaiah Inventory of Learning processes (ILP) (Schmeck et al., 1977) was developed by extrapolating ideas from Craik and Lockhart (1972) to the process of academic studying. The instrument is composed of 62 true-false items, arranged in four scales: synthesis-analysis, study methods, fact retention, elaborative processing. The Inventory was developed to assess "the behavioral and conceptual processes which students engage in while attempting to learn new material" (Ribich & Schmeck, 1979).

In 1984 Schmeck worked with Entwistle and Ramsden to produce an instrument combining their approaches. The "Inventory of Approaches to Studying and Learning Processes" uses 75 items to cover the combined scales from the Entwistle and Ramsden instrument and the Schmeck instrument. The considerable degree of correlation which resulted supports the thematic relationship between these two instruments. These combined studies are described in Schmeck (1988).

The Learning and Study Strategies Inventory (LASSI) was first published by Weinstein, Palmer and Schulte in 1983 and updated for a 1987 publishing. This instrument

has 77 items, each requiring a response on a five-point Likert scale. The items are sorted to ten dimensions: anxiety, attitude, concentration, information processing, motivation, scheduling, selecting the main idea, self-testing, study aids, test strategies. The LASSI is "an assessment tool designed to measure students' use of learning and study strategies and methods. As a diagnostic and prescriptive measure, it assesses both covert and overt thoughts and behaviors that relate to successful learning and that can be altered through educational interventions. Evidence exists that these thought processes and behaviors contribute significantly to success in post secondary educational and training settings and can be learned or enhanced through educational interventions". (Weinstein, 1987, p. 2)

Witkin et al. developed the *Embedded Figure Test* in 1971 with eighteen pictorial items. Non-meaningful geometric target shapes must be located within larger non-meaningful geometric shapes. Items are scored for time and accuracy. Scores place respondents on one bipolar scale measuring degree of field dependence/independence. This measure was developed to reveal a respondent's "general tendency to function at a more differentiated or less differentiated level."

A form of the test that can be administered in groups, the Group Embedded Figures Test, is also available. Recent work by Shade (1984) supports the proposition that these tests measure individual variation in perceptual preference patterns rather than behavioral tendencies.

IV. EVIDENCE FOR IMPROVED EDUCATIONAL OUTCOMES THROUGH USE OF LEARNING STYLE INFORMATION

Apart from the challenge of detecting students' characteristic styles of learning with the diagnostic instruments we have described, educators must face the ultimate question of whether (and how) the use of this information improves learning. This synthesis does not attempt an exhaustive review of this issue, but selected literature is discussed to illustrate important questions, and to provide examples of the type of research that has been conducted. It should be noted that there are examples in the published literature of studies showing no discernable effect attributable to learning style variation (for example, Cholakis, 1986; DeGregoris, 1986; Stiles, 1985; and Tappenden, 1983). Given the predilection in the scholarly press towards considering positive results more interesting than negative or null results, the true proportion of negative results found across learning style investigations is probably greater than might be inferred from considering only the studies mentioned below.

The quality of evidence offered by studies in this field can also be diminished by four other problems. (1) Many studies have been conducted by Ph.D. students under the direction of a faculty member with a vested interest in substantiating a particular learning style conceptualization. (2) A recurrent design problem is the potential for statistical regression which biases interpretation of results when comparison groups were selected on the basis of extreme scores. (3) Few of these studies estimate the reactive effects of pretesting for learning style which may sensitize students to experimental instructional conditions. (4) Students may also be reacting to the experimental arrangements instead of

the experimental variable (Hawthorne effect). These external threats to validity are ignored in the research designs presently used in learning style research.

Given these design limitations, the published evidence available seems, nevertheless, to support three broad conclusions: 1) matching aspects of the instructional situation to a student's cognitive learning style will result in improved attitudes and increased achievement, at least in initial stages of learning; 2) matching testing conditions and style improves test scores; and 3) learning strategies can be taught directly within some developmental constraints.

Focusing on research with secondary school students, the following studies illustrate the evidence available.

A. Instruction

Douglas (1979) systematically matched and mismatched secondary school science students from six midwestern schools. Two schools were in rural areas, two in inner cities and two in affluent suburbs. The total sample of 627 students was half female and half male. Results from all schools were pooled for analysis. The learning style measure was of field dependence/independence (Witkin et al., 1971). General intelligence was measured with the Otis-Lennon Mental Ability Test and was used as a covariate. The dependent measure was gain from pre-test to post-test on three content units. Results indicated that students were more academically successful when instructional materials and approach matched their style of thinking.

Tanenbaum (1982) measured 248 high school students using the field dependence/independence (Witkin et al., 1971) measure and assigned 100 students who were clearly classifiable in one extreme or another to two versions of a nutrition lesson differing in degrees of structure provided. Results indicated a significant interaction effect between the students' learning style and the instructional method, demonstrating a positive effect for match.

Steele (1986) investigated secondary school students in an alternative curriculum program. He discovered a tendency for students' preferred learning styles as measured by the Myers-Briggs Type Indicator (Myers, 1962) to correspond with distinctive learning practices of these same students. The intuitive students sought new possibilities and avoided perceived stable conditions whereas the sensing students sought experiential approaches to learning through the alternative program structures.

DeBello (1985) studied 236 eighth grade students in a suburban school using the Dunn et al. (1985) measure of learning style. He concentrated on the sociological preference scale for peer learning, learning with an adult, or learning alone. Students with clear preferences in each of these dimensions were assigned randomly to writing instruction strategies that were either congruent or dissonant with their preferences. Results indicated that when students worked in approaches congruent with their learning style, statistically better attitudes towards the task resulted. A holistic scoring system for the writing products

indicated that achievement scores were significantly higher when instruction strategies were matched to student learning style.

Hodges (1985) studied thirty-two seventh and eighth grade youngsters in a remedial mathematics class and focused on the environmental design preference (formal or informal) as measured by the Dunn et al. (1985) instrument. Results indicated significant differences when subjects were randomly matched and mismatched with instructional environments that were congruent or incongruent with their diagnosed design preference. Students achieved significantly higher mean scores and demonstrated statistically more positive attitudes when matched with complimentary instructional settings.

Kroon (1985) studied 65 secondary school industrial arts students using the Dunn et al. (1985) instrument focused on response preference (auditory, visual or tactile). Findings indicated that achievement was significantly greater when instruction was introduced through the students' preferred perceptual learning style and then reinforced through either their secondary or tertiary style.

Lynch (1981) studied a group of 136 chronically truant eleventh and twelfth graders using the Dunn et al. (1985) instrument focused on time-of-day preference. The study matched or mismatched time preference with a specific series of assignments across two consecutive years and evaluated the amount of truancy. Findings demonstrated that matching for time preference resulted in significantly more attendance.

B. Testing

Results of improved achievement and attitude in matched learning situations have been complemented by two studies which matched testing conditions with student style. Neither of these studies assessed the effect of an instructional component but both discovered significant improvements in performance on examinations when the examination setting was congruent with the student's style.

Murrain (1983) followed 268 seventh grade students and used the Dunn et al. (1985) instrument to diagnose preference for temperature. Subjects were then randomly assigned to experimental testing groups for a word recognition task. All subjects were tested twice in balanced order, once in an instructional setting congruent with their temperature preference and once in an environment incongruent with their preference. Results indicated higher scores obtained in congruent environments.

Shea (1983) assessed 410 ninth graders using the Dunn et al. (1985) instrument to determine student preference for environmental design. Taking extreme groups on this style dimension and screening out IQ scores outside the 85 - 115 average range resulted in 32 students who were randomly assigned to be tested for reading comprehension in formal or informal designed environments. Results indicated that when preferences were matched to complimentary environmental designs, reading comprehension scores were significantly increased.

C. Direct Training

Evidence has been accumulating on the efficacy of direct training to develop aptitudes or learning strategies necessary for further instruction. McCombs (1981, 1982a, 1982b) provides considerable evidence that it is possible to directly train self-motivational skills, time management skills, and study skills. The purpose of this direct strategy training is to improve students' perceptions of "self efficacy and personal causation that underlie ability to take positive self control and change negative attitudes and orientation towards themselves and learning" (McCombs, 1984). She lists a series of specific skills amenable to training packages in this area including: self assessment/evaluation, setting realistic self-standards, planning, self-monitoring, self-correction and self-reward, goal setting, deriving positive expectations for success, managing stress, and learning to effectively communicate feelings and needs. Goldfried, Linehan and Smith (1978), working with older adolescents using rational restructuring as a method of reducing test anxiety, reported significant reductions in anxiety across a range of different measures as compared to control groups.

It appears that a range of specific cognitive skills are also amenable to direct instruction. Palincsar and Brown (1984) created a cross-tutoring system labelled "reciprocal teaching" by which students were first taught and then taught their peers strategies such as self-questioning during reading. Similar effects have been observed with guided learning and co-operative learning efforts as outlined by Dansereau (1988). Weinstein and Mayer (1986) reviewed the evidence for direct teachability of a range of specific cognitive skills. Their review itemizes a range of specific investigations in which students were directly taught useful cognitive skills such as specific elaboration and rehearsal strategies (Jones and Hall, 1982), complex rehearsal strategies involving note-taking (Carrier & Tietus, 1981), organizational strategies (Bjorklund, Ornstein & Haig, 1977), comprehension monitoring (Bommarito & Meichenbaum, 1979; Wong & Jones, 1982; and Malamuth, 1979). Letteri (1980) has developed a series of specific strategies for augmenting each of the seven bipolar dimensions of his cognitive control profile. Through a series of concrete to abstract exercises combined with direct instruction and self-verbalization, students are taught to be more analytic, more focused, more reflective, more sharply focused, tolerant, narrowly targeted and complex.

It should be noted that there may be an age below which it is impossible to directly train some useful cognitive skills. Flavell (1970) and Flavell and Wellman (1977) observed that young children (6th grade and younger) are often aware of different rehearsal strategies but generally fail to apply them in learning tasks. Flavell labels this a "production deficiency." Appel et al. (1972) observed that older children (sixth grade and over) are better able to identify and employ learning strategies appropriate to specific tasks. Brown and Smiley (1977) discovered that children younger than sixth grade cannot identify differentially important information in prose. Pressley and colleagues (Pressley, 1977, Pressley & Dennis-Rounds, 1980, Pressley & Levin, 1978) found that children older than eighth grade students spontaneously generate key word images to help in memorization, whereas younger children do not. The cognitive skill of information organization to aid memory also appears to improve with grade level beyond an effective cutoff of about sixth grade (Bjorklund, Ornstein, & Haig, 1977).

V. CONCLUSIONS

The learning styles field offers tantalizing possibilities. Conceptualizers, instrument developers and researchers promise to enable students, teachers and parents to take better control of learning. As yet, however, many important claims about the nature of learning styles, the validity of diagnostic instruments and the effects of their use to improve instruction have not been systematically evaluated in practice.

Both researchers and practitioners can improve the current state of learning style theory and application in education. A considerable range of studies are needed to improve the validity of learning style conceptualizations. Distinctions among like concepts must be made to establish construct-related evidence for validity, and much more work needs to be done connecting responses to learning style measurements with learning behaviors and learning outcomes in classrooms. Developing generalizable estimates for variance sources will give valuable information on the reliability of the current learning style measurements as would defining the standard errors of measurement around cut scores in each of the learning style classification schemes.

Practitioners interested in applying learning style concepts may be interested in considering the utility of learning style measurement as a strategy toward adaptive education. Adapting instruction to suit the needs and aptitudes of a particular group of learners has always been practiced by insightful teachers. Students are ill-suited to a curriculum when either the student has not mastered the necessary content background or supporting knowledge and skills, or has not developed the information processing approach (cognitive control) required by the particular curriculum. Depending on the situation and the student, a teacher could choose to concentrate on direct training of the missing content knowledge and skills and perhaps direct training of the necessary information processing approach (cognitive control). Alternatively, the teacher could choose to proceed with content instruction in an entirely new manner which does not require prior master of the "missing" content knowledge, skills and information processing. By making either of these choices the teacher could conceivably preserve student motivation and self-esteem while the missing information or approach is learned. To make either adaptive choice requires information about the student, some of which may be provided through various of the learning style concepts and measurements systems. Reference to Figure 2 may offer some guidance about which of the existing measurement systems may be most applicable with particular students, particular curricula and particular teaching situations. All potential users of learning style measurement systems are cautioned to read deeply and critically about the learning style conceptualizations they propose to use.

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TABLES OF INSTRUMENTS

The following tables summarize each of the thirteen recommended learning style concepts and measurements systems. The columns are to be read vertically; there are no rows in the tables. All references are contained in the Reference section.

An example interpretation for the first table indicates that the theories advanced by Biggs have resulted in two measurement systems: the Study Process Questionnaire (SPQ) published in 1986 for use with college and university students; and the Learning Process Questionnaire (LPQ) also published in 1986 for use with secondary school students. The content of both the SPQ and LPQ are measured on five point Likert scales in a self-report format and a fifteen minute time span. The scales measure four motive strategy dimensions: surface-reproducing; deep-intrinsic; achieving-organizing; deep-achieving. Only LPQ item information is supplied. A total of forty-two items is divided across the four scales: eight items, eight items, eight items and six items. Scoring is a procedure of summing ratings for motivation strategy within each scale.

Data is available on both internal and temporal reliability for the LPQ. One study (Biggs, 1988a) was conducted with 1,700 fourteen year olds and showed an average alpha across the four motive strategy dimensions of .63. The range of the alphas across these same four motive strategy dimensions was .46 to .77. Temporal reliability published by Biggs (1988a), was collected on a set of 60 students sixteen years of age with a time span of four months between testings. Across the sixty students the range of alphas was .49 to .72 with an average of .61.

This instrument has available to date only construct validity information. Appropriate correlations were noted with self-rated performance (.16 to .30 on the LPQ); with school performance (.20 to .30 LPQ and .30 to .40 SPQ) by Watkins in 1983. Biggs in 1985 reported appropriate correlations with internal locus of control for the LPQ, but he did not report the correlations.

The remaining tables can be interpreted following this model.

Author & Title	Content	Reliability			Validity		
		Internal	Temporal	Other	Face	Construct	Predictive
Biggs Study Process Questionnaire (SPQ) 1986 (college/ university) Learning Process Questionnaire Learning Process (LPQ) 1986 (secondary School)	5 point Likert scale Self-report 15 minutes 4 motive-strategy dimensions 1. Surface; reproducing 2. Deep; intrinsic 3. Achieving; organizing 4. Deep; achieving LPQ: # items=42 # items/scale= 8,8,8,6 Scoring: sum of ratings for motive and strategy in each scale	LPQ Alpha Av.r=.63 Range=.46-.77 N=1700 Age = 14 Alpha Av.r=.63 Range=.45-.78 N=1700 Age=16 (Biggs, 1988a) SPQ Alpha Av.r=.73 Range=.51-.85 N=2100 university students Alpha Av.r=.67 Range=.55-.78 N=245 university students Alpha Av.r=.71 Range=.60-.77 N=unknown (Biggs, 1988b)	LPQ Test/retest Av.r=.61 Range=.49-.72 N=60 Age=16 Span=4 months (Biggs, 1988a) Test/retest Av.r=.65 Range=.60-.70 N=69 Age=16 Span=4 months (Biggs, 1988a)			Appropriate correlations, -with self rated performance .16-.30 (LPQ) with school performance .20-.30 (LPQ) and .30-.40 (SPQ) (Watkins, 1983) -with internal local control (figures not reported) (LPQ) (Biggs, 1985)	

Stated Purpose: To measure these three concepts which the author believes "offers a parsimonious and theoretically coherent model for conceptualizing the more important ways in which students may feel about, and behave towards, their study" (Biggs, 1979).

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Author & Title	Reliability			Validity			
	Content	Internal	Temporal	Other	Face	Construct	Predictive
Dunn, Dunn and Price Learning Style Inventory (LSI) 1974, 1987 Productivity Environmental Preference Survey (PEPS) Adult version of LSI 1979, 1986	True-False Self report 40 minutes 22 scales Environmental Elements: 1. Noise Level: Quiet or sound 2. Light: Bright or low 3. Temperature: cool or warm 4. Design: Informal or formal 5. Highly or poorly motivated 6. Persistent or not persistent 7. Responsible or not responsible 8. Structure: needs or does not need Sociological Elements: 9. Prefers learning alone or with peers 10. Prefers learning with authority figure 11. Prefers learning in several ways Continued....	Hoyt Av.r=.76 Range=.55-.88 Av.S.E.= 1.30-2.28 Range=1.72 N=890 Grades 5-12 (Dunn, Dunn & Price, 1989)	Test/retest One subscale only (time of day preference) Av.r=.93 Range not reported Span=1 year N=163 4th, 5th and 6th graders (Virostko, 1983)				Matching some individual style elements to teaching environments increases academic achievements (Dunn, Dunn & Price, 1989) Matching mobility preferences of 7th grade students predicted improved performance on recognition and memory tests (Valle, et al. 1986) Matching acoustic environment with individual style increases 6th grade reading comprehension scores (Pizzo, 1981) Matching design environment with individual style increases 9th grade reading comprehension scores (Shea, 1983) Matching time preference with target class time reduced truancy 11th and 12th grade (Lynch, 1981)

Author & Title	Reliability				Validity		
	Content	Internal	Temporal	Other	Face	Construct	Predictive
Dunn, Dunn and Price (continued)	Physical Elements: 12. Auditory preference 13. Visual preference 14. Tactile preference 15. Kinesthetic preference 16. Requires (oral) intake 17. Functions best in evening/morning 18. Functions best in late morning 19. Functions best in late evening 20. Mobility Motivation Factors: 21. Parent figure 22. Teacher motivated # items 104 # items/scale=2-8 Scoring: total number items answered in keyed direction for scale						

Stated Purpose: "Analyze the conditions under which students in grades three through 12 prefer to learn" (Dunn, 1983)

Author & Title	Content	Reliability			Validity	
		Internal	Temporal	Other Face	Construct	Predictive
Entwistle & Ramsden Approaches to Studying 1983 -shortened versions -adapted for secondary schools -adapted for medical students	5 point Likert scale Self report 15 minutes 4 scales: 1. Meaning orientation 2. Reproducing orientation 3. Achieving orientation 4. Holistic orientation # items = 64 # items/scale =16 Scoring: sum of ratings assigned to items comprising each scale	Alpha Av.r=.70 range=.50-.79 N=unspecified (Entwistle & Ramsden, 1983) Alpha Av.r=.61 Range=.79 .32-79 N=1193 high school students (Entwistle, & Kozeki, 1985) Alpha Av.r=.63 Range=.50-.74 N=218 College Students (Waterson, 1985)	Test-retest Av.r=.72 Range=.63-.79 N=391 High school students Span=3 weeks (Entwistle & Ramsden, 1983)	Considerable qualitative research (student) interview based) developed initial item pool Similar results between scale dimensions and progress in 2nd year university N=491 Arts =852 Social Science Av.r=.29 Range=.14-.44 (Entwistle & Ramsden, 1983)	78% agreement in classification between interview and instrument (Watkins, 1983) Factor analysis of disciplines across items and scales in 2 cross-national samples (Entwistle & Ramsden, 1983) Factor analysis considerable overlap with Schmeck's categories (Waterson, 1985)	Predicted relationship between scale scores and achievement in 6 British college majors N=491 English and History N=852 Economics and Psychology N=865 Physics and Engineering Av.r=.24 Range=.04-.32 Similar results in Australian college disciplines N=295 Arts N=89 Science Av.r=.45 Range=.41.-54 (Entwistle & Ramsden, 1983) Predicted relationship between scale scores and achievement in arts and sciences courses for British and Hungarian high school students Av.r=.16 Range=.02-.38 N=164 British =579 Hungarian (Entwistle & Kozeki, 1985)

Stated Purpose: To define approaches to learning and styles of learning in ways which are directly related to the experience of students that will inform teachers about their student's study that "they will be in a better position to organize their teaching to ensure that students learn effectively." (Ramsden, 1983)

Author & Title	Content	Reliability				Validity	
		Internal	Temporal	Other	Face	Construct	Predictive
Grasha & Riechman Student Learning Scales (GRSLS) 1974	5 point Likert Self report 15 minutes 6 scales: 3 bipolar scales 1. Independent 2. Dependent 3. Avoidant 4. Participant 5. Collaborative 6. Competitive # items=90 # items/scale=15 Scoring: sum of ratings assigned to items comprising each scale	KR-20 Av.r=.60 Range=.76-.83 N=269 college students Span=7 days (Riechmann, 1972)	Test/retest Range=.76-.83 N=269 college students (Hruska & Grasha, 1982)			Moderate correlations with "Criterion Item Questionnaire" (r=.22-.45) for three scales (avoidant participant, collaborative) Poor correlation (r=.13-.28) for other 3 scales (Riechmann & Grasha, 1974) Factor analysis confirms the quality of scales (Riechmann, 1972)	Patterns generally as predicted rated learning benefit, involvement and interest in peer-centered and instructor-centered course N=102 undergraduate college students (Andrews, 1981)

Stated Purpose: "To develop an instrument that was based on the type of learning styles students demonstrate in the classroom" which they felt was the appropriate approach "if teachers are to innovate and take student learning needs into consideration." (Riechmann & Grasha, 1974)

Author & Title	Content	Reliability: Internal	Reliability: Temporal	Reliability: Other	Validity: Face	Validity: Construct	Validity: Predictive
Hunt Paragraph Completion Method (PCM) 1971	Completion of sentence stems Self report 15 minutes 6 sentences stems 1. What I think about rules... 2. When I am criticized... 3. What I think about parents.. 4. When someone does not agree with me... 5. When I am not sure... 6. When I am told what to do... Scoring: sum of rater assigned scores (0-3) corresponding to level of conceptual complexity, interpersonal maturity and self-other understanding. Result is one bipolar dimension "conceptual level"		Test/retest Span=1 year 5 groups Grades 6-11 N=6-126 Av. r=.50 Range=.45-.56 (Hunt et al. 1978)	Interrater 25 studies --students of various ages --patients --principals --supervisors N=15-84 Median r=.86 (Hunt et al. 1978)		Correlations with measures: integrative complexity (.49), ego identity (.37), and anxiety (-.56) N=100 twelfth grade females (Raphael et al. 1979) Various published and unpublished studies cited in review (Miller, 1981) significant relationship claimed with level of social, cognition, effect level and achievement	

Stated Purpose: To determine student's level of "conceptual complexity, interpersonal maturity and self-other understanding." (Miller, 1981)

Author & Title	Content	Reliability			Face	Validity	
		Internal	Temporal	Other		Construct	Predictive
Kagan Matching Familiar Figures Test 1964	Visual matching to-sample Self Report Time varies 1 scale (bipolar) (reflective/impulsive) # items=12 # items/scale=12 Scoring: Time to the first response and number of errors overall	Split half r=.70 N=undefined Second grade children (Yando, 1968)	Test/retest Av.r=70 Range=.46-92 N=120 Second grade children Span=10 weeks (Yando & Kegan, 1970)			Correlation with other similar measures (6 studies) Av.r=.57 Range=.33-.73 (Messer, 1976)	

Stated Purpose: To estimate the degree that people will reflect on the validity of solution hypotheses in problems that contain response uncertainty.

Author & Title	Content	Reliability			Validity		
		Internal	Temporal	Other	Face	Construct	Predictive
Keefe & Monk, NASSP Learning Style Profile (LSP) 1986	--forced choice 3-5 alternatives --self report --not timed --24 scales; 4 factors 1. perceptual response 2. cognitive style 3. study preference 4. instructional preference # items = 126 # items/ scale=varies high=20 (perceptual response) low=2 (early a.m. time) Scoring: sum of scores in each scale	Three national field tests were conducted. Total N=3702-5131 H.S. students (Keefe & Monk, 1988) Average Alpha=.59 Range=.47-.72 Note: that one scale (simultaneous processing) has no internal consistency indication as yet	Ten day and 30 day test-retests were conducted N=166-234 H.S. students Average 10 day r=.62 Range=.53-.82 Average 30 days r=.48 Range=.21-76 Note: Two scales (categorization, simultaneous processing) have no test/retest data (Keefe & Monk, 1988)		All scales were developed based on existing literature	Most scales are supported by strong factor scores in development phases Some scales have no validity data presented (Keefe & Monk, 1988) (categorization, simultaneous processing, sound preference) Some scales have been correlated with related existing scales --analytic with GEFT r=.39 --perceptual responses with ELSIE r=.51-.64 --various subsections of Dunn et al. with manipulative (r unspecified) --study time r=.66, .49, .54 --grouping p=.002 (r not available) --posture r=.50 --mobility r=.66 --light r =.70 --temp. r=.65,.58	

Stated Purpose: To "show you your learning style-how you learn and how you like to learn. (This) will help you know yourself better and aid your teachers in their teaching." (Keefe & Monk, 1989).

Author & Title	Reliability				Face	Validity	
	Content	Internal	Temporal	Other		Construct	Predictive
Kolb Learning Style Inventory (LSI) 1971,1981, 1985 Adaptive Style Inventory (ASI) 1979	Rank order Self report 5 minutes 4 scales: 2 bipolar concepts 1. concrete experience 2. reflective observation 3. abstract conceptualization 4. active experimentation # items=9 # items/scale=9 Scoring: sum of ranks assigned to items comprising each scale	Split half Av.r=.69 Range=.55-.82 N=687 undergraduates & graduate students, managers (Kolb, 1981) Alpha Av.r=.79 Range=.73-.82 N=268 undefined age (Kolb, 1985)	Test/retest Av.r=.58 Range=.48-.73 N=27 medical students Span=3 months (Kolb, 1981)			Correlations with existing --aptitude tests, --creativity tests, --personality test, --(MNTI, TAT, FIRO-B) Pattern of correlations supports constructs for preferences, types of learning situations (lectures, seminars, projects, term papers, etc.), preference for types of teachers (Kolb, 1976) Factor analysis of LSI showed two bipolar scales and a measure of instructional preference (Marshall & Merritt, 1985)	

Stated Purpose: To describe "the best way you learn and how you deal with ideas and day to day situations in your life." (Kolb, 1985)

Author & Title	Content	Reliability			Face	Validity	
		Internal	Temporal	Other		Construct	Predictive
Myers-Briggs Type Indicator (MBTI) 1962	Forced choice Self report 40 minutes 4 bipolar concepts 1. Extraversion-Introversion 2. Sensing-Intuition 3. Thinking-Feeling 4. Judgement-Perception # items = 143 # items/scales= 34-44 Scoring: sum choices for each pole; determine direction strength of preference to produce single preference score on each concept	Split half Av.r=.86 Range=.80-.88 N=91 Medical students (McCaulley, 1978)	Test/retest Av.r=.78 Range=.70-.83 N=56 Undergraduates Span=8 months (McCaulley, 1978)			Correlations with many existing personality tests --16 PF --OPI --OAIS --Alport-Vernon --Vernon-Lindzey --Rokeach --Watson-Glaser --Cancer attitude --Medical preference Patterns of correlation support constructs (McCaulley, 1978)	Longitudinal in which MBTI scores used to predict specialty choice, modes of practice, professional activities, board certification, professional appointments, society memberships, urban or rural residence N=5355 medical and dental students Span=12 years (McCaulley, 1977)

Stated Purpose: The pattern of results generated by the four bipolar concepts are interpreted in terms of Jungian personality theory which in turn is used to predict behavior and attitudes.

Author & Title	Reliability				Validity	
	Content	Internal	Temporal	Other Face	Construct	Predictive
Rezler & Rezmovic Learning Preference Inventory (LPI) 1974	Rank order Self report 15 minutes 6 scales: 3 bipolar concepts 1. Abstract 2. Concrete 3. Individual 4. Interpersonal 5. Student-structured 6. Teacher-structured # items=15 # items/scale=15 Scoring: sum of ranks assigned to items comprising each scale	Alpha Av.r=65 Range=.58-.73 N=159 allied health workers (Rezler & Rezmovic, 1981)	Test/retest Av.r=72 Range=.61-.85 N=14 adult health professionals Span=4 months (Pers. comm., 1985) Test/retest paired t-tests Av.r=1.58 Range=.02-5.20 N=89 occupational health students Span=14 months (Rogers, 1980)		Moderate correlations with MBTI r=.20-.38 Subscores inter-correlated across 2 samples Patterns of scores differ in expected ways across different types of samples (Rezler & Rezmovic, 1981) Subscores uncorrelated with Kolb LSI or Witkin GEFT N=95 medical students (Communication from author)	

Stated Purpose: "To identify preferred modes of learning" with preference defined as the "choice of one learning situation or condition over another." (Rezler & Rezmovic, 1981)

Author & Title	Reliability				Validity	
	Content	Internal	Temporal	Other	Face	Construct	Predictive
Schmeck, Ribich & Inventory of Learning Process (ILP) 1977	True/False Self report 10 minutes 4 scales: 1. Synthesis analysis 2. Study methods 3. Fact retention 4. Elaborative processing # items=62 # items/scale=7-23 Scoring: total number of items answered in keyed direction for each scale	KR-20 Av.r=.70 Range=.58-.82 N=434 undergraduates (Schmeck et al. 1977) Alpha Range=.48-.63 N=428 undergraduates (Watkins & Hattie, 1981)	Test/retest Av.r=.83 Range=.79-.88 N=95 undergraduates (Schmeck et al. 1977)			Correlated with "Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1964) & Williams' Cognitive Preference Test (Williams, 1975) N=54 Pattern of correlations with measures of curiosity, achievement, anxiety, imagery support construct Av.r=/.34 Range=.18-52 N=100 undergraduates (Schmeck & Ribich, 1978) Factor analysis Considerable overlap with Entwistle categories (Waterson, 1985)	Predict scores on other trait tests (curiosity, achievement, anxiety, imagery) Multiple R Av.4=.44 Range=.32-.55 N=100 undergraduates (Schmeck & Ribich, 1978) Predict success on school evaluation components (test, papers) Av.r=.39 Range=.24-.67 N=58 undergraduates (Lockhart & Schmeck, 1983)

Stated Purpose: To assess "the behavioral and conceptual processes which students engage in while attempting to learn new material." (Ribich & Schmeck, 1979)

Author & Title	Reliability					Validity	
	Content	Internal	Temporal	Other	Face	Construct	Predictive
Schroder Completion Test (PCT) 1967	Completion of sentence stems Self Report 15 minutes 5 sentence stems 1. When someone disagrees with me... 2. When I am in doubt... 3. Rules... 4. When others criticize me it usually means... 5. Confusion Scoring: trained rater assigns each response a score (1-7) corresponding to a level of conceptual maturity	Split half r=.75 N=100 university students (Bottenberg, 1969)	Test/retest r=.67 Span=3 months N=36 college students (Gardiner & Schroder, 1972)	Inter-rater r=.91 N=100 university students (Gardiner & Schroder, 1972		Low, positive r's (.2 range) with other measures of complexity and low negatives r's (.2 range) with opposite variables (authoritarianism and domination) (Schroder et al. 1967) Low, positive r's (.2 range) with related concepts (intellectual flexibility, openness, differentiation) (Bottenberg, 1969)	Complexity predicts degree of conflict in playing chess (Stager, 1967) Subjects high on complexity use wider variety of concepts, rules (Schneider & Giambra, 1971)

Stated Purpose: To indicate "the integrative component of cognitive complexity" which is defined as the ability to think in multi-conceptual terms. (Schroder et al. 1967)

Author & Title	Reliability				Validity	
	Content	Internal	Temporal	Other	Face	Construct	Predictive
Weinstein et al. Learning and Study Strategies Inventory LASSI 1983	5 point Likert scale Self Report 30 minutes 8 dimensions --anxiety (8 items) --attitude (8 items) --concentration (8 items) --info. processing (8 items) --motivation (8 items) --scheduling (8 items) --selecting main idea (5 items) --self testing (8 items) --study aids (8 items) --test strategies (8 items) # items 77 # items/scale see above Scoring: sum of ratings in each scale	Alpha Av r=.75 Range=.60-.88 N=783 college freshman (Weinstein et al.1988)	Test-retest Av.r=.74 Range=.64-.81 N=95 college freshman Span=3-4 weeks (Weinstein et al. 1988)			--correlation of info. processing scale with Schmeck's elaborative processing scale r=.60 (Weinstein et al. 1988) --correlation of selecting main idea with direct test of same r=.40 (Weinstein et al. 1988)	

Stated Purpose: "To measure student's use of learning and study strategies and methods." (Weinstein, 1987)

Author & Title	Reliability				Validity	
	Content	Internal	Temporal	Other Face	Construct	Predictive
Witkin Embedded Figures Test (EFT) Group Embedded Figures Test (GEFT) 1971	Visual segmentation Self report Time varies 1 scale (bipolar concept field dependence) EFT: # items=18 # items/scale=18 Scoring: mean solution time per item GEFT: # items=25 # items/scale=25 Scoring: sum correctly identified figures	Split half r=.82 N=397 Undergraduates (Buros, 1978) Split half Av.r=78 Range=.61-.92 high school students Split half Av.r=.82 Range=.79-.85 college students Split half Av.r=.86 Range=.82-.90 N=53 "older students" (Witkin et al. 1971)	Test/retest r=.90 N=27 "general students" Span=7 years (Witkin, 1967) Test/retest Av.r=.85 Range=.78-.92 N=43, 75, 76 university students Span=6 wks., 0 time, 10 days (Kepner & Neimark, 1984)		Wide range of studies relating performance to: --other disembedding functions --psychological differentiation --body concept --nature of defenses --forms of pathology --physiological reactivity --family and cultural activities (Witkin, 1967)	

Stated Purpose: To reveal a respondent's "general tendency to function at a more differentiated or less differentiated level." (Witkin, et al. 1971)